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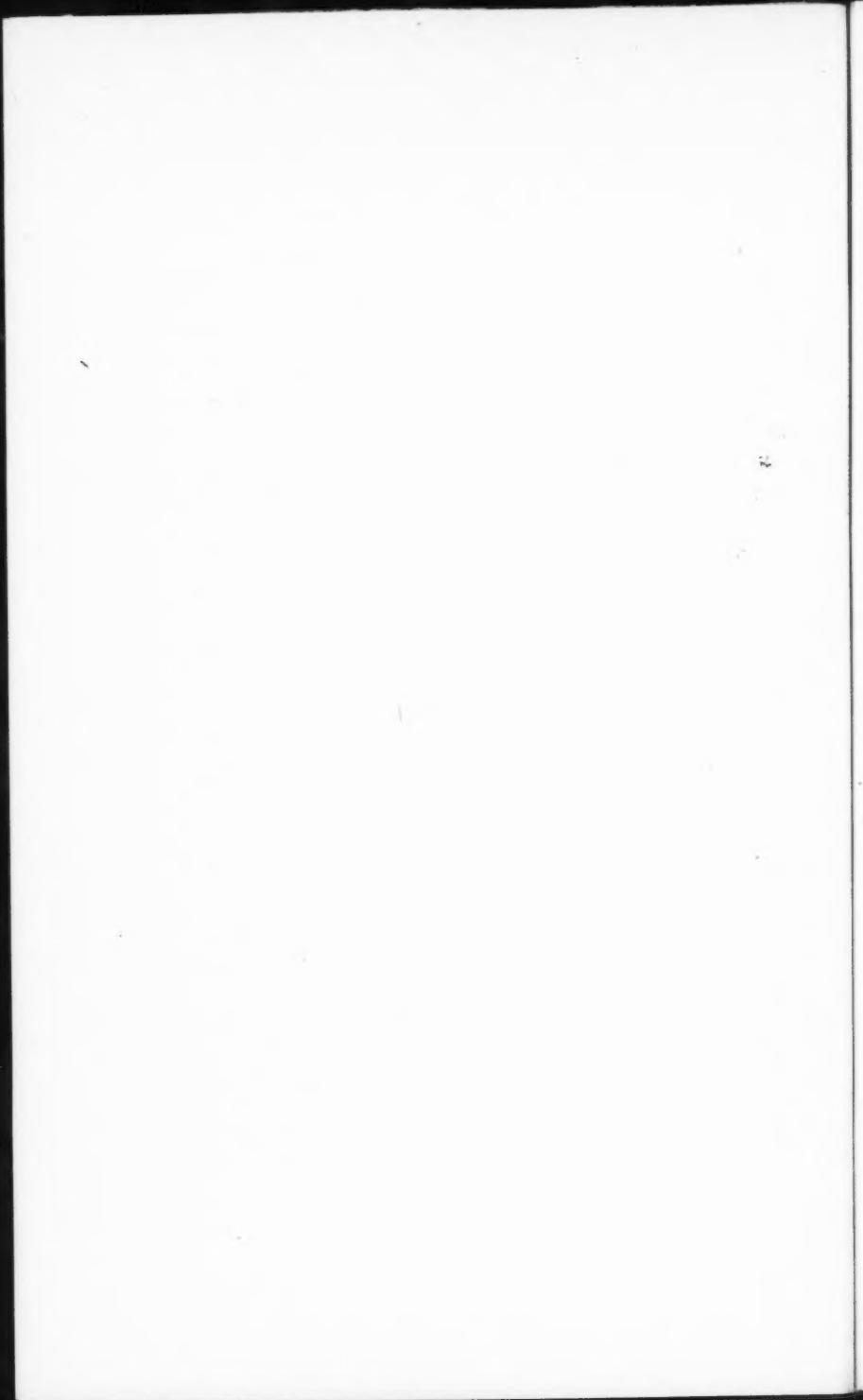
MIDLAND NATURALIST

DEVOTED TO NATURAL HISTORY, PRIMARILY
THAT OF THE PRAIRIE STATES

JULIUS A. NIEUWLAND, C. S. C., PH.D., SC.D.
EDITOR

VOLUME XI.—1928-29

UNIVERSITY OF NOTRE DAME
NOTRE DAME, INDIANA



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VOL. XI.

JANUARY, 1928.

No. 1.

The American Midland Naturalist

Devoted to Natural History, Primarily
that of the Prairie States

Published by the University of Notre Dame,
Notre Dame, Indiana

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PRICE \$1.50 A Year

SINGLE NUMBERS 30 CENTS

FOREIGN, 6s. 6d.

Entered as second-class matter at Notre Dame, Indiana. Acceptance for mailing at
special rate of postage provided for in section 1103, Act of October 3, 1917,
authorized on July 3, 1918.

THE UNIVERSITY PRESS, NOTRE DAME, INDIANA

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The American Midland Naturalist

PUBLISHED BI-MONTHLY BY THE UNIVERSITY OF NOTRE DAME,
NOTRE DAME, INDIANA.

Vol. XI.

JANUARY, 1928.

No. 1.

ECOLOGIC INTERPRETATIONS OF SOME BIOSTRATIGRAPHIC TERMS

By CARROLL LANE FENTON AND MILDRED ADAMS FENTON

I.—FAUNULE AND ZONULE *

The purposes of this paper, and the one to follow it under the same general title are:

1. To clarify and re-define certain biostratigraphic terms now in use.
2. To propose certain new terms to supplement earlier ones.
3. To inquire into the nature and bases of these terms, and the nature of the criteria of value in their application.

To a considerable extent, this inquiry into the nature of terms will be along the lines of ecology, even though the terms themselves may not come properly within the limits of that science. We think, however, that several biostratigraphic terms are more closely involved with ecology than generally has been recognized, while others become significant only when they have been given firm ecologic bases. To do this is one of our aims.

Discussion purposely has been restricted to the marine, invertebrate aspects of paleobiology. We have no doubt that

* Contributions from the University of Cincinnati Museum. Geology and Paleontology. Number 2.

the terms involved are applicable to other fields, but feel that the limitations of our own studies make it necessary that such application be made by other hands than ours.

Illustrations have been drawn chiefly from the upper Devonian rocks of Floyd and Cerro Gordo Counties, Iowa. It was in studying these formations that we first appreciated the great usefulness of the term faunule, while the demand for such a one as zonule has been precipitated by the work of Mr. C. H. Belanski, on the Shellrock stage. We have profited much from the free use of Mr. Belanski's manuscript, and also from the criticisms of Drs. Walter H. Bucher and Stuart Weller. To the latter we are indebted for the original suggestion of the term zonule.

Mr. Belanski's paper already has appeared in volume 10, pages 317-370 of this journal; and certain differences between his usage of terms and ours are explained by the fact that the present paper was not completed until some months after Mr. Belanski's article went to press.

WILLIAMS' INTERPRETATIONS OF FAUNULE

The word faunule, in a technical paleontologic sense, was introduced by H. S. Williams in Bulletin 210 of the U. S. Geological Survey,—The Correlation of Geological Faunas (1903). In a footnote to page 6 he gives the following definition:

"The term 'faunule' is here and in the following pages used to distinguish an aggregate of fossils associated in a single stratum or zone from the total aggregate of species (the fauna) distributed through a greater or less thickness of strata, each faunule containing a considerable proportion of the same species, but not always in the same combination or proportionate abundance. The association in the faunule is supposed to be an expression of the temporary adjustment to environment and to each other of the living species—an adjustment determined by the relative vigor of each species; whereas the fauna is an aggregate of species determined by several quite divergent conditions and factors, the fauna liv-

ing on so long as these conditions and factors remained sufficiently intact to permit it to preserve its general characteristics and the dominant species to maintain their relative place in the fauna, though for a time suffering more or less variation of composition, due to local and temporary conditions."

The term is mentioned repeatedly in the paper, with explanations or comments that are significant. We select three:

"When a fossiliferous stratum is discovered . . . the paleontological observer stops and samples the stratum. The fossils thus gathered constitute a *faunule*," (Page 24.)

"The faunule is a sample of the fossil contents of a fossiliferous zone . . ." (Page 24.)

"A fauna is an association of species which for some reasons naturally live together . . . A faunule is a local sample of the fauna." (Page 29.)

On page 131, finally, Williams gives a "revised definition" of the term faunule, as follows:

"In the process of collecting fossils it is necessary to keep separate records of the specimens taken from each fossiliferous stratum of each separate outcrop. The group of specimens from such a unit stratum (or from several contiguous strata in which the same set of species are distributed) is called a *faunule*. It is a sample of the general fauna of the formation, coming from a definite horizon in the local section and from a definite geographical position. A faunule will exhibit the local and temporary aspects of the fauna, and in most cases it will contain only a small part of the species which properly belong to the general fauna. The faunule may be regarded as closely adjusted to a particular set of environmental conditions, which, though not known, may be to some degree inferred by the character of the sediment in which it is found. It is often observed, however, that successive faunules in a column of strata differ greatly, although very slight change in character of sediments is observed. Living faunas in modern ocean waters so differ on account of differences of temperature or other conditions of the water, and it may be supposed that such differences affected in a similar way the ancient geological faunas."

In the next paragraph Williams turns to the rocks which afford a faunule, saying:

"The particular part of the formation, be it a single stratum, or a few or many feet of thickness of rock throughout which the faunule is recognized is properly a *zone*, as defined on page 20; and the locality, number, and name may be applied to the specimens of the faunule, as well as to the stratum or strata from which they came."

Page 20 affords a general discussion of fossiliferous and barren zones that is not significant here; but page 22 contains a statement that is important, and will be referred to farther on. It is:

"A zone may be traced from place to place, as may the formation itself . . ."

We now may turn to Williams' notable report on "Recurrent *Tropidoleptus* Zones of the Upper Devonian in New York,"—Professional Paper 79 of the U. S. Geological Survey (1913). Once more we select but a few of the possible quotations:

"In the work for this paper 1,411 separate faunules were collected and examined . . ." (Page 8.)

"The faunules listed above are the individual local collections made and recorded in the field. When these collections were studied in the laboratory the separate lots from contiguous strata found to contain the same fauna were for individual sections combined and treated as a single faunule. . . (Page 43.)

"In the Harford quadrangle the recurrent faunule of zone No. 1 has been detected at three or four separate horizons ranging through at least 100 feet . . ." (Page 79.)

"Specimens of the genus *Rhipidomella* have been detected in 88 of the 1,411 individual collections of faunules examined . . ." (Page 42.)

The interpretation which Williams gave the term zone in 1913 is well illustrated by Fig. 2 of Professional Paper 79, in which several zones are shown to extend well beyond the limits of a single quadrangle.

CONFLICTING INTERPRETATIONS

If we now scrutinize and compare the definitions and characterizations of the term faunule that have been quoted, it becomes plain that Williams had in mind three different things. The first of these is a group of organisms, dwelling in a more or less restricted area, and adjusted to themselves and their inorganic environment. The second is a collection of fossils, from one or several contiguous strata, at one locality. The third is a group of fossil organisms, not clearly a community, which characterizes a given stratigraphic unit, or zone.

Beyond reasonable doubt, Williams had the organic group or community in mind when he framed his first definition. The members of this community, of course, were present only as fossils; but they once were alive, adjusted to their environment and each other, though varying somewhat in their relative abundance from spot to spot. All these are attributes of organisms, not of fossils in a collection.

It is just as plain, however, that on page 24 of Bulletin 210, Williams is thinking of the collection—"the fossils . . . gathered." On page 43 of Professional Paper 79 he is even more explicit: "The faunules . . . are *individual local collections . . .*" (Italics ours.) But in his "revised definition," Williams incorporates both the idea of organic community and that of collection. "The group of specimens" is a faunule; but the faunule seems to be "closely adjusted to . . . environmental conditions," responding to them as do modern faunas, and smaller ecologic groups. Moreover, a faunule characterizes a zone; and though it is not thoroughly clear that in this use of the term Williams was accepting the faunule as a community, certainly he was not considering it to be nothing more than a collection of fossils from one locality or outcrop. Such an interpretation clearly is ruled out by the statement that a zone "may be traced from place to place, as may be the formation itself. . . ."

Finally, in spite of his clear statement on page 43, and his use of faunule in the bulk of the book, Williams returns, on page 79 of the "Recurrent *Tropidoleptus* Zones," to the

concept of faunule as a faunal community, when he says: "In the Harford quadrangle the recurrent faunule of zone No. 1 has been detected at three or four separate horizons ranging through at least 100 feet, although in the section at the typical locality (Van Etten) it [the zone] appears to be not over 20 feet thick." This zone extends into at least two fifteen minute quadrangles, and according to Williams' definition of zone (Bulletin 210, page 131) the faunule must do likewise. In keeping with this interpretation of faunule, also, is an expression found on page 42 of Professional Paper 79: "individual collections of faunules." (Italics ours.)

There seems no need to review in detail the use of faunule by other authors than Williams. In the first place, the term is rare in paleontologic literature; in the second, we have found no other writer who has critically analyzed the term, even when he used it.

We may say, however, a word about our own use of faunule in the "Stratigraphy and Fauna of the Hackberry Stage of the Upper Devonian" (New York, 1924). In giving the range of several forms—*Strombodes marginatus*, for example—we referred to the faunules in which they were found, or were dominant, the stratigraphic position of these faunules being given in a series of sections printed on pages 10 to 13. In these sections, unfortunately, the name of the faunule is given in the position which should be occupied by that of a stratigraphic unit, as in this example from page 12:

2. Whitneyi Faunule. Gritty, blue beds with casts of
Atrypa, *Spirifer*, *Schizophoria*, etc.; at the top there
are traces of No. 3 of the Rockford section 8

It now seems to us that the practice of giving ranges in terms of faunules, while perhaps not generally useful, is in keeping with Williams' major definition, and the one we propose to adopt; but that the use of faunule in place of a stratigraphic term, as in the example quoted, is inadmissible. It would give the term a stratigraphic meaning, implicitly if not explicitly, and such a meaning not only would be distinct from any given the term by Williams, but would violate the

word itself. We therefore abandon this objectionable usage, and in further discussion of faunule shall limit ourselves to Williams' interpretations and definitions.

FAUNULE AS A COLLECTION

Having found that Williams gave the term faunule two, or even three distinct meanings, we confront these alternatives: either the term must be dropped, or it must be defined anew in accordance with one or another of Williams' interpretations. The former seems undesirable since, as we shall show farther on, there is need for such a term as faunule. Therefore, it is necessary for us to decide which of Williams' meanings to accept,—which of his interpretations to follow.

At the outset, we may dismiss without detailed consideration Williams' third interpretation of faunule, as the assemblage of organisms which characterizes a zone. To us this seems no more than a supplement to his major interpretation, as community; since a fossil community, or community-like assemblage, may and often does characterize a statigraphic unit, even though we should not call that unit a zone. But the most significant point is this: that Williams gives his third interpretation casually (and ambiguously) and does not return to it,—from which we may conclude that he himself did not consider it as very important.

Let us now turn to the concept of faunule as one collection, from one or a few contiguous strata, at one outcrop. In this sense a collection becomes a faunule only by virtue of the care used in making it and in preserving data; and the use of the term implies that the precision of these data is comparable in the case of all collections to which faunule is applied.

This, unfortunately, need not be true. In precision, the data accompanying a collection from a six-inch bed with an exposure roughly five by twelve feet are not comparable to those of a collection made from a four-foot member exposed in an escarpment five thousand feet long. In linear precision alone the data differ as twelve differs from five thousand. Moreover, in the mile-long outcrop that we have in mind,

there is one member which, in various parts of the exposure, contains different organic assemblages, while the six-inch bed, in the five-by-twelve foot outcrop contains but one assemblage. Yet Williams' definition of faunule as collection would demand that collections from both of these members, *in toto*, be called faunules. Clearly that definition must be modified to read "collection from one outcrop or part of an outcrop." Without such modification, the faunule ceases to be a natural unit, and invites confusion rather than clarity.

Let us now consider the other extreme. Williams unites several faunules (collections) into one if they belong to one biologically limited stratigraphic division at one outcrop. But what shall we do with those not uncommon cases in which the same organic community is present, in apparently identical strata, at several outcrops a number of miles apart? Shall the collections from these be made distinct faunules, with different names, as the definition requires? Or shall we adopt the more rational device of uniting them under one name, as one faunule, and thus avoid confusing and constantly multiplying synonyms?

If the modifications of definition suggested by these last paragraphs are accepted, the revised definition of faunule as collection will read about like this:

A faunule is one or several collections, from one or several contiguous and faunistically related strata, at one outcrop, part of an outcrop, or series of outcrops in which this stratum or these strata afford specimens which indicate the existence of one continuous organic community.

The significant thing about this definition is not its series of alternatives; it is the shift of emphasis from *oneness* of locality to *continuous* unity or organic content. To us it seems that collections whose affinity is determined by the fact that they come from one stratigraphic unit at one outcrop are very different things from collections whose affinity is determined by the fact that the rocks from which they came seem to contain one continuous organic community, whether at part of one outcrop, or throughout a dozen outcrops. If one accepts our second definition he must discard the first.

But why accept either? We have seen that the implied precision of data may be an illusion—yet what other justification have we for calling a collection by some name other than collection? Moreover, these very qualities of precision are attributes of all really careful collecting; and as conditions of field work improve we may (theoretically, at least) reach a state in which most collections, in this sense, might be called faunules. Collection, then, would become a term of deprecation or reproach, indicating that time was short, talus thick, cliffs steep, or that the collector had neglected an opportunity. Such a distinction seems hardly to possess scientific validity.

In conclusion: we find that the term faunule, in the sense of a collection, has no place in biostratigraphy. Introduced as a precise term, its precision is relative—and without emendation of the original definition, illusory. One of its essential criteria, oneness of outcrop, fails of application, and a new criterion, of organic unity, must be introduced. Finally, the precision denoted, while based on nature, depends primarily on factors more or less independent of the strata and fossils; followed to its limit, it produces distinctions which are arbitrary and absurd.

FAUNULE AS A FAUNAL ASSEMBLAGE

We now may turn to the other conception of faunule, stated by Williams in his first definition of the term, in the first part of his "revised definition," and implied in his conception of zone and in the more general descriptions of his Professional Paper of 1913.

As a basis for discussion, we may take Williams' first definition, quoted on page 2 of this paper. According to it, a faunule is not a collection, but is the fossil representation of a group or community of living animals, that dwelt in a limited area during a limited period of time, and that were closely adjusted to the environment, of which they themselves formed an important part.

Unfortunately for the paleontologist, he is forced to give much latitude to the word "representation;" this latitude being

demanded by irregular operation of those processes by means of which organisms are buried and fossilized. To be truly, accurately representative of the once living community, a group of fossils should not merely afford the important species of the group, but should preserve them in approximately their correct proportions, and without additional or intrusive forms properly belonging to another habitat, and therefore, another community. Features of the organisms or their preservation, also, should give more than hypothetical evidence of their life habits.

These conditions, however, fossil assemblages rarely meet. Forms with hard parts are preserved while those without them disappear. Large, massive ones, such as many of the corals and bryozoans, stand out more prominently than their numbers justify, and are more common in collections than are their small contemporaries. Plankton and nekton, when preserved at all, lie among dwellers of the sea bottom, while many a shell has drifted far from its original habitat.

Of course, there are various criteria by means of which the accuracy of fossil representation may be gauged. If the community is a coral reef, affording organisms of the sort that normally inhabit reefs, one may assume that few intruders have been washed in. If amidst thousands of perfectly preserved brachiopods and corals, without a sign of wear, one finds delicate Auloporoids adhering to the still semi-plastic clay of the one-time seabottom, he may assume that this sector, at least, was undisturbed by waves or currents. On the other hand, broad ripple marks, worn fragments of shells, and flat valves on edge in imbricating channels, all give equally conclusive evidence of disturbance.

But such conclusive criteria are not always available. Also, it may not be the purpose of the paleontologist to concentrate upon a group so limited that it is properly an association, even if it can be distinguished. In either case, what he has for study is a representation of the plant or animal population of a given area during a given time, minus unknown subtractions, plus undetermined (or undeterminable) additions, and representing, probably, more than one habitat.

It is such an assemblage, we believe, that Williams had in

mind when he first defined the term faunule, and it is to such an assemblage that we would apply the term today. There is no other which properly may be used. As Williams shows, fauna has too broad a meaning; ecologic terms cannot be applied, since the assemblage is but partly determined by ecologic criteria. On the other hand, the term faunule fits excellently, and it has no other valid significance.

It is clear, however, that though a faunule is not an association, it is dominated by the representatives of one community which in all probability is (or was) an association.¹ This is true of the faunules we have chiefly in mind—those of the Hackberry Stage (Upper Devonian) of Iowa, and the ones distinguished by Belanski in the Shellrock strata of the same region. There is, for example, one faunule dominated by large, massive colonies of the bryozoan *Liocloma occidens*, with the various brachiopods, corals and other animals that grew among, upon and even within the bryozoan masses. Another faunule is characterized by abundant, large brachiopod shells of the genera *Atrypa* and *Spirifer*; a third by thousands of rugose corals and their ectoparasites; a fourth by abundant, massive stromatoporoids and corals.

In each of these faunules, therefore, it seems possible to pick out the dominant association; certainly one may distinguish those small organic communities which the ecologist calls layer societies, or strata.² On the other hand, each fossil

1 An association may be defined briefly as a qualitatively and quantitatively homogeneous community of plants or animals, occupying a common habitat. For a discussion of the ecological classification of plants, see Nichols, Ecology, vol. 4, pp. 11-23, and 154-179, 1923. The classification which Nichols proposes can be extended to animal communities with but little change.

2 The term stratum was used by Shelford (Animal Communities of Temperate America, p. 37, 1913) to designate a group of animals within an association, living at approximately the same level. Since this interpretation conflicts with the standard stratigraphic meaning of the term, it cannot be accepted in paleobiology.

The equivalent term, layer society, is defined by Nichols (1923, p. 14) as "a plant community within an association which results from the tendency of various species of smaller size than the dominant life-form to display their foliage at more or less definite levels." As ex-

assemblage contains remains of organisms which did not enter the dominant association until they died and sank to the bottom, others, members of the nekton and vagile benthos, that entered and left more or less at will, and still a third group concerning which evidence is not and may never be convincing. It is these three groups that make the assemblage distinct from any purely ecologic group, and demand for it some peculiar designation, such as faunule.

A faunule, therefore is not truly an ecologic unit, even though it is in part determined by such a unit, or community. From this it follows that in distinguishing faunules we must give attention, not merely to index species or faunal lists, but to the essential faunal constitution of the assemblages in question. Two fossil assemblages may afford almost identical lists of species, and contain the index fossils of the formation or zone, and yet form faunules that are absolutely distinct. To the casual collector many of the faunules of the Hackberry stage would seem identical, yet as the four examples that have been given indicate, their dominant life-forms are very different. In the first, this dominant form is the massively branching bryozoan, *Lioclema occidens*, fragments of whose zoaria are present in thousands. In the last, the dominant life forms are massive stromatoporoids, and twelve years of collecting have brought to light but one small fragment of *Liocloma occidens*. Yet in the ordinary, non-annotated faunal list this single fragment would stand out quite as prominently as the thousands of specimens from the other faunule! Even such qualifications as "very rare" and "abundant" will not bring out the contrast.

The most satisfactory method for determining the true complexion of a faunule seems to be this: In the two or more strata whose faunal contents are to be compared, areas are selected which are comparable in slope, in size and in degree

amples he quotes the small tree, tall shrub, low shrub and herbaceous layer societies in an oak-hickory forest. In a crinoid-bank (association) the snails and other organisms about the crinoid bodies, and the molluscs, bryozoans, etc., about their bases form equally distinct layer societies.

of weathering, and which are free from the talus of higher beds. From these areas of exposure every available fossil is taken, while notes are made concerning the matrix and exposure, and any other features than may be significant. When the fossils have been identified, their names are tabulated, with the number of specimens in each case; and the result is census tables of the faunule or faunules.

In analyzing these lists, each form must be weighed according to its significance, and that of the parts which represent it. A thousand echinoid spines have not the significance of a thousand snail shells—yet if one bed affords a thousand spines and another but one, there is at least indication that echinoids are more common in the former. Similar considerations apply to such forms as the branching bryozoans, to crinoids, and to all other animals in which one individual may be represented by many pieces.

Somewhat similar considerations enter when one seeks to determine the ecologic importance of several forms. One may find two hundred ostracods, and still may not call ostracods the dominant life-forms of a particular faunule; but if in the same space he finds thirty masses of *Prismatophyllum*, he will call that form dominant, state that the faunule is dominated by a *Prismatophyllum* community, and name it accordingly.

In some cases, of course, the collection-census method of faunule analysis cannot be applied. In them the collector will devise a method that fits the conditions, and do his best to gain an accurate idea of the complexion of the faunule.

In the great majority of cases, naturally, a faunule will contain many species, not three, six or a dozen. But to this rule there will be exceptions: particularly those faunules whose dominant life-forms built large colonial masses, and whose environmental conditions were such that small species were rarely preserved. But even in such cases species will not determine the faunule; it is their relative abundance, and the presence of some of them in communities, which furnish the decisive criteria.

Another exception, more apparent than real, will be found

in the faunule whose dominant and subdominant life-forms are so large and abundant as to render the other species relatively insignificant. Thus in a stromatoporoid reef, one or two species of stromatoporoids, and perhaps a coral or two, may form ninety per cent of the mass of the faunule; and for practical purposes they alone may be identified. But the other forms exist, and form part of the faunule, so that in careful work (generally the only sort in which faunules will be recognized) they will be listed, and their proportionate abundance noticed.

In summary, therefore, we may say this: that, although the faunule is not a truly ecologic unit, the criteria by which it is distinguished, and the methods by which its constitution is determined and described, are primarily ecologic. Under no conditions can it be defined merely in terms of index species.

Because of this last statement, it may be well to add a word about those fossil assemblages which, though they contain several species and many specimens, afford no recognizable trace of organic communities. Into this group fall shell beds accumulated by waves and currents, comminuted masses of exoskeleton with here and there an identifiable specimen, the fossils of sparsely fossiliferous beds, and many similar accumulations. Obviously enough, such assemblages were determined by physical agents, not by ways of life. At their base is no ecologic unit or community; they represent neither adjustment to environment, nor of organisms to each other. To them, therefore, the term faunule cannot be applied. They are simply assemblages, and nothing more.

RE-DEFINITION OF FAUNULE

We come now to the point where we may offer a revised definition of the term faunule. For the science of paleontology alone, this may be phrased as follows:

A faunule is an assemblage of fossil animals, associated in one or a few contiguous strata, and dominated by the representatives of one community, commonly either an association or a layer society.

It seems doubtful, however, that the term should be restricted to paleontology. To the ecologist, of course, it may be useless, since he has more precise terms that fit his needs. But zoologists often describe animal assemblages which extend beyond the limits of one community. Particularly is this true of those who work with dredging samples, containing benthos, nekton and plankton in one lot; and to these workers the term faunule should be welcome.

It seems, therefore, that any general definition of faunule should allow it to be used by both zoologist and paleontologist, without conflict of meaning. This is not difficult, since the qualifications which would restrict the term to paleontology are not essential. A fossil animal differs in no essential character from a living one—particularly if the latter is dead. Association of fossils in one or a few strata may be taken for granted if their assemblage is dominated by a community, since a community is a temporary affair at best, and even in the sea is not apt to endure through geologically long periods.³ Therefore, though we may allow the paleontologic definition to stand as precise and specific (though by no means final) for that science, it seems well to give the term *per se* a more general definition, such as this:

A faunule is an assemblage of animals dominated by one community or its representatives, but including organisms which, though found among the members of the community, do not belong to it.⁴

3 Exceptions may be necessary for such communities as the larger coral reefs. But for those of the Paleozoic the generalization seems good.

4 The term florule, being the counterpart of faunule, presumably may be defined similarly, by the substitution of "plants" for "animals." This also is true of the purely paleontologic definition.

DUAL USE OF FAUNULE

Like the purely ecologic term association, faunule may be used in two senses, concrete and abstract.⁵ At first this may seem unnecessary and confusing; actually it accords with our common daily practice. We speak of the pine woods of Florida, and of the pine woods two miles east of Crystal Beach, Florida, but the two are distinct. The first is a generality, an abstraction; the second is a precise thing—a bit of woodland that anyone may locate and examine. The same applies to such examples as the seashore, and the seashore at Woods Hole, Massachusetts, and many others that might be mentioned. Even the names of geologic formations are given dual usage, though the contrast is more between general and specific than between abstract and concrete.

In the case of faunule, however, the duality of usage principally will involve the concrete and abstract. In the former sense the term will signify a particular faunal assemblage: for example, the *Actinostroma expansum* faunule at Nora Springs, Iowa. In the latter, it will signify an abstract concept, based, it is true, upon specific cases, but itself neither specific nor tangible. Such usage is adequately illustrated by the following statement: "The *Actinostroma expansum* faunule, wherever it appears, maintains the character of a bottom reef in shallow, but quiet water."

CORRELATION AND RECURRENCE OF FAUNULES

The existence of a faunule is determined by the presence of members of a definite organic community, plus organisms not members of that community, and still others whose position is in doubt. The constitution or complexion of the faunule is determined by the nature of the constituent animals, their relative abundance, and their relationships to each other.

⁵ On the dual use of association, see Nichols, *Ecology*, vol. 4, pp. 14-17, 1923. This article, which seeks to rescue ecologic nomenclature from the complexity into which it has been carried by some enthusiastic classificationists, constantly has been at hand during the preparation of this paper. The classification of Shelford, already mentioned, is important, particularly since it relates directly to animals.

It follows, therefore, that when two assemblages correspond in these particulars, they are to be considered representatives of the same faunule, and may be given the same faunule name.

In such a case as this there are three possibilities. If the assemblages appear in outcrops not widely separated, and in apparently continuous strata, one may assume that the community which dominates them is continuous, and that they represent a single faunule, in the concrete sense of that term. This seems to be the condition Williams had in mind when, calling the rocks bearing a faunule a zone, he stated that the latter might be traced from place to place.

On the other hand, the exposures commonly are far apart, while between those in which one member bears two similar assemblages are other exposures in which the same member bears a faunule or several faunules unlike the first. In such cases continuity can not exist, even though some of the assemblages are similar—homologous, in both constitution and stratigraphic position. In the concrete sense they form two faunules, even though they may be considered as individual examples of the general abstract faunule.

Examples of this sort are common in modern seas, as well as in the deposits of ancient ones. Coral reefs, contemporaneous and essentially similar, are separated by areas of bottom that do not bear reefs. Colonies of *Mytilus edulis* grow in isolated spots, surrounded by deposits of black mud; beds of oysters, sponges and other marine organisms are separated as distinctly. And although they now form communities, their fossil counterparts may more properly be termed faunules—homologous faunules—in the majority of cases.

Just what the limits of vertical disparity between faunules of this type shall be must depend upon the nature of the formation in which they occur. In the upper Devonian of Iowa, with numerous stratigraphic units, commonly separated by unconformities, a few feet or even inches may make a great difference in age. On the other hand, we are inclined to consider the reefs of the Racine dolomite in the Chicago region as homologous, since there seems to be (at present) no good basis for stratigraphic distinction. The cores of the tepee buttes of the Pierre shales, described by Gilbert and

Gulliver,⁶ contain other examples of homologous faunules which may not be strictly contemporaneous.

There remain those cases in which apparently or actually similar faunules occupy levels so different, or strata so distinct, that the term homologous cannot be applied to them. If the similarity is real, embracing both the dominant community and the more important of the secondary or incidental forms, we may conclude that the faunules actually are equivalent in constitution. They therefore correspond to the recurrent faunules of Williams (mislabeled *zones*; Professional Paper 79), and to them this designation may be applied.⁷

Commonly, however, the similarity between distinctly non-contemporaneous faunules will prove to be apparent rather than real. During the passage of time organisms, unless they become extinct, continue reproduction; and all of them, even the "arrested" types, are subject, during this process, to some evolutionary change. To paleontologic perception, moreover, evolution seems a nearly continuous process; even mutations are apt to appear so against the background of geologic time.⁸ Unless the period separating two faunules is very slight, therefore, many of their organisms will show modification—especially those in the so-called racial reproductive period, such as the "species" of *Spirifer* in the Hackberry stage, and of *Cyclonema* and *Platystrophia* in the Cincinnati and Richmond.⁹ Under such conditions there is

6 Bull. Geol. Soc. Am., vol. 6, pp. 333-342, 1895.

7 Actually, only those faunules after the earliest recur; yet all of them form a recurrent series. Moreover, the abstract or generalized faunule, which includes the first as well as the last of the series, recurs. With this understanding, the term recurrent, when convenient, may be applied to the original faunule without grave abuse of words.

8 See W. D. Matthew on the Evolution of the Horse, etc. (Quart. Rev. Biol., vol. 1, pp. 139-185, 1926), for a discussion of this point.

9 A striking example of rapid evolution is furnished by the modern genus of lung-snails, *Partula*. See H. E. Crampton on Contemporaneous Organic Differentiation in the Species of *Partula* living in Moorea, Society Islands (Am. Nat., vol. 59, pp. 5-35, 1925). More elaborate discussions of the genus, by the same author, are to be found in publications 228 and 228A of the Carnegie Institution of Washington.

small chance that the organisms composing non-contemporaneous faunules will be alike, even though they may not always be so different as to separate the faunules.

Still other factors make actual recurrence of faunules uncommon. Not merely must the dominant community reappear without any very considerable modification of its constituent elements; into this community must come virtually the same array of extraneous and uncertain species that accompanied its first appearance. And even though a good deal of latitude be given the qualifications "considerable" and "virtually," there still is small chance that in any individual case these conditions will be met. In our own work we have found no ease in which a faunule recurs, nor has Mr. Belanski encountered recurrence in the Shellrock, whose faunules are numerous and well developed.

On the other hand, recurrence doubtless does occur—Williams' recurrent "zones" of *Tropidoleptus* seeming to be a case in point. Commonly, however, the recurrence will involve, not the actual faunule, but an abstract, almost ideal grouping of organisms which we may call the *faunule type*, and which involves ecologic and taxonomic resemblance, rather than equivalence. This is strikingly shown in Cenozoic and recent coral reefs, and in the long series of oyster beds of past and present periods. In both of these examples distinct faunule types recur unknown numbers of times, while actual recurrence of faunules is relatively uncommon.

There doubtless are cases in which one element of the faunule—the association or layer society—actually recurs, although other elements do not repeat themselves. In such cases one may speak of the recurrent community, whatever its rank, but not of recurrence of the faunule, since it is more than a community. As in the examples quoted in the preceding paragraph, the similar but non-contemporaneous faunules lack a common essential constitution, and are analogous rather than recurrent.

In summary, we may give the following classification of faunules with reference to their repetition, both areal and vertical:

Homologous Faunules. Faunules of essentially equivalent

constitution, generally occupying the same stratum or member, and virtually contemporaneous.

Recurrent Faunules. Faunules of essentially equivalent constitution, but occurring at distinctly different horizons, and therefore not contemporaneous.

Analogous Faunules. Faunules occurring at distinctly different horizons, not of equivalent constitution, but characterized by a common faunal type.

NAMES OF FAUNULES

It seems desirable that a faunule be named, when possible, after the dominant life-form of its characteristic community. Not always, however, is this possible; the dominant form may be very imperfectly known (almost any stromatoporoid, for example), or the name may have been used in some other connection, thus inviting confusion if it were applied to the faunule. In such instances names must be devised which seem best to meet the needs of the case.

Our present preference is for both generic and trivial names, if a faunule is named for a particular species. But the point does not seem a vital one, and if one term will do as well, as Mr. Belanski has found in the case of the Shellrock faunules, the addition of another word may be undesirable. Fortunately, the case is one in which uniformity is not vitally important, though precision and clarity are.

ZONULE

On page 6 we commented unfavorably upon our own use of faunule in a stratigraphic sense. We return to the matter with the proposal of a new term.

In many cases the vertical and horizontal ranges of fossils may be given in terms of the faunules of which they form parts. Not always, however, is this the case, and in sections and stratigraphic descriptions the term faunule obviously will not suffice. Of course, one might use such an expression as "beds containing the *Pugnoides calvini* faunule," but the device is so clumsy as to be nearly worthless.

Williams (Bulletin 210, page 131) applied the term zone

to the rocks containing a faunule, though he seems not to have held uniformly to this interpretation. It seems to us, however, that to follow Williams in this would be to restrict the term zone undesirably, violate established usage, and greatly lessen its usefulness.

The term subzone, suggested by the United States Geological Survey (letters of July 28, 1926 and January 26, 1927) does not seem appropriate. Like substage, it suggests a division into vertical, not areal, units which are apt to be coextensive with the larger unit, whether stage or zone. But a division based upon faunules is both areal and vertical, and rarely indeed does a faunule extend over the same area as a zone. To us the idea of numerous subzones, all at one stratigraphic horizon, is confusing and contradictory. Finally, there seems to be need for the term in another, and more appropriate sense.

We have discussed the need for some new term to designate the rocks bearing a faunule with several stratigraphers. In the course of one conversation Dr. Weller suggested "zonule," and it has been approved by the others, among whom are Dr. Walter H. Bucher and Dr. E. M. Kindle. We propose the term, therefore, with the following definition:

A zonule is the stratum or strata which contain a faunule, its thickness and area being limited by the vertical and horizontal range of that faunule.

It seems desirable that a zonule be given the name of the faunule which it contains. If the faunule is repeated homologously the zonule also is repeated. If the faunule is repeated by recurrence, it seems desirable that the zonule name be preceded by one of the numerical adjectives, in order that the zonules of different levels may be distinguished.

Following the nomenclature proposed for faunules, zonules bearing homologous faunules are themselves homologous. On the other hand, it seems necessary to call those zonules bearing recurrent faunules analogous. For a zonule consists of rocks, not organisms, and rocks are fixed, powerless to migrate, and biologically, have no descendants. The rocks of analogous zonules may be very similar, but that similarity is very different from similarity based on organic continuity.

If it represents recurrence of any sort, it is of sedimentary type, not of actual beds. Recurrent zonules do not exist—nor do recurrent stratigraphic units of any other rank.

There remain those zonules which bear, not recurrent, but analogous faunules. It seems that they too may be termed analogous, even though their relationship differs from that of the analogous zonules just discussed. To us, that difference does not seem so great as to warrant the introduction of another new term.

BEDS

As we have said, several zonules generally occur at one horizon, in a single stratum or member. In many cases they are adjacent or even intergrade, but in others they are separated by expanses of rock which either are barren, or hold assemblages of fossils too poor to form faunules. Similar nonfaunaliferous breaks appear in the vertical sequence.

To these barren or semi-barren beds the term zonule cannot be applied, even if they are mere areal continuations of strata which do form zonules. We would not assign them a special term, however, but rather would refer to them as "beds" or "member" as the case might be.¹⁰ Such designations are sufficiently precise for sections and descriptions, and use of them makes it possible to restrict "zonule" according to the definition—which seems necessary if it is to retain significance.

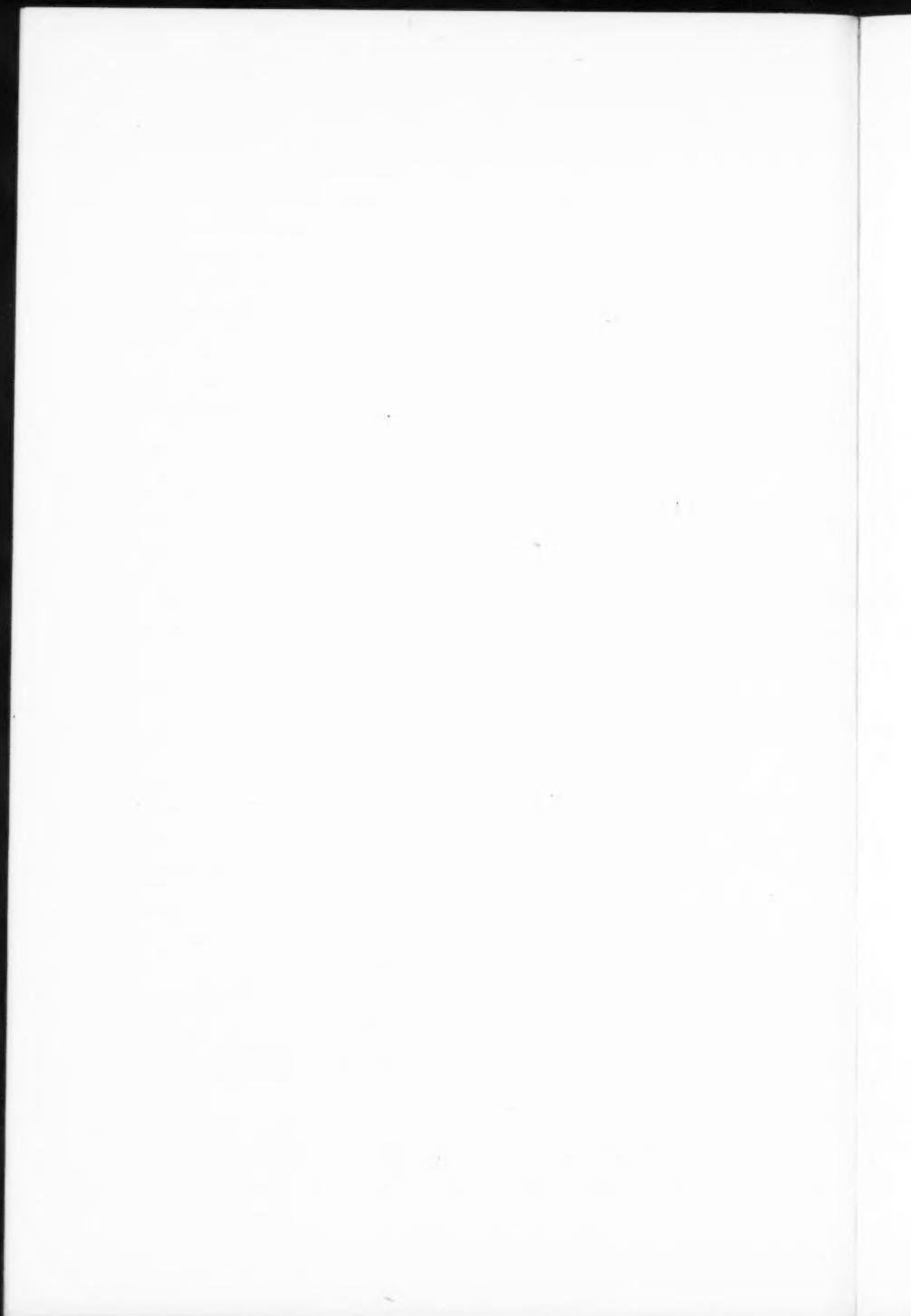
SUMMARY

Under the term faunule, Williams included two major but distinct concepts: one of a collection precisely made and labeled, the other of an organic assemblage in close relationship to its environment. In this paper the former of these, as an interpretation of faunule, is rejected, since it is of slight use, is virtually synonymous with "collection," and is out of keep-

¹⁰ Here we differ from C. H. Belanski, who uses such terms as 'dolomite zonule' (This journal, vol. 10, p. 348, 1927). This portion of our paper was written too late for Mr. Belanski to examine it in preparation of his manuscript, but his present opinion agrees with ours.

ing with many of Williams' own applications of the term. The latter concept, however, is accepted with but slight modification, and is made the basis for a re-definition of the term faunule: not merely because it is the one first stated by Williams, but because it possesses real value in biostratigraphy, and agrees with Williams' more important applications of his term.

A new term, zonule, is proposed for the strata containing a faunule, and some general suggestions are offered concerning its use and restrictions.



*Compliments
of B. J. Bush*

THE MISSOURI ARTEMISIAS

BENJAMIN FRANKLIN BUSH

In the study of the few species of *ARTEMISIA* in this paper, I have experienced more difficulty than I ever encountered in the study of any group of species. Judging by the names given to the specimens by collectors, my own included, it appears that few persons understand or know the species.

I was led to make an examination and study of the Missouri species, by finding a patch of some species of *Artemisia*, near the mouth of the Kaw River in 1926, the stems of which were somewhat suffrutescent, the branches of the season and the flowering branches, springing from the old stems of the previous year or years.

No species of *Artemisia* being known to me for Missouri having this suffrutescent character, I was undecided as to whether it just happened that this patch only, showed this woody character, or if it was a species of the West, that had become introduced at this particular place, there being no doubt that it was introduced.

In looking through the lists of Missouri plants and consulting authorities on the genus *Artemisia*, I noted some very interesting things, and these I will deal with further on in this paper. It is very apparent that very few of those who published lists of Missouri plants knew the species of *Artemisia*, and as I proceeded to consult the authorities, it became very apparent to me that they differed very widely from each other in their views and conceptions of the species, and the ranges of them.

The first account of the species of *Artemisia* found in Missouri that I have found, is in Torrey and Gray (18), where six species are cited for Missouri; but at that time the term Missouri meant anywhere North of Louisiana, north to Canada and Montana; following Torrey & Gray is Pech (12), who lists *A. canadensis* in his catalogue for Louisiana, Missouri; the next list published of Missouri species, important in point

of the number of species listed, is Tracy's Catalogue (19), in which eight species of *Artemisia* are listed for Missouri, three of which cited from previously published lists or floras; the last important list published so far as number of species is concerned, is Mackenzie and Bush (10), in which eight species of *Artemisia* are described for Jackson County, Missouri, and strangely enough, all correctly given.

Through the courtesies of Prof. Shantz of the University of Illinois, Dr. L. H. Pammel, of the Iowa State College, Dr. Wm. R. Maxon, of the United States National Museum, Mr. Kenneth K. Mackenzie, of Maplewood, New Jersey, and Mr. Chas. C. Deam, of Bluffton, Indiana, who have loaned me much *Artemisia* material, and otherwise assisted me by the loan of literature bearing on this study, I have been enabled to prepare this paper, and I hereby return my sincere thanks for this assistance.

1. *ARTEMISIA GLAUCA DRACUNCULOIDES* (Pursh) n. var.
A. dracunculoides Pursh, Fl. Am. Sept. 742, 1814.
A. dracunculus Pursh, Fl. Am. Sept. 521, 1814. Not *A. Dracunculus* L. 1753
A. nutans Fraser; Pursh, Fl. Am. 742, as synonym, 1814.
Not *A. nutans* Willd., 1804.
A. Nuttalliana Besser; Hook. Fl. Bor. Am. 1: 326, 1833.

TYPE LOCALITY: Upper Louisiana, now South Dakota. Cited for Missouri by Torrey and Gray (18), Tracy [19], Hall and Clements (9), Bush (4), Mackenzie and Bush (10), Rydberg (15), Robinson and Fernald (13), Britton & Brown (2), and Gray (8), but all of these must certainly refer to *A. cernua*.

I have been unable to separate *A. dracunculoides* from *A. glauca*, of which it appears to be only a more diffuse, taller, glabrous form.

Hall and Clements (9) cite *A. dracunculoides brevifolia* and *A. dracunculoides tenuifolia* for Missouri, citing Torrey and Gray (18) for their authority, but Torrey and Gray did not cite these two varieties for Missouri, Hall and Clements being mistaken in so reading Torrey & Gray.

The citation in Britton & Brown (2) and Rydberg [15] are based on specimens collected by me at Sheffield, Missouri, No. 3961, and as they were certainly introduced plants, they may have been brought in by trains from the Northwest.

SPECIMENS EXAMINED:

MISSOURI: Sheffield, *Bush* 3961, June 13, 1906, M. Herb.

Typical *glauca* and the larger, diffuse, more glabrous form that has been taken to be *A. dracunculoides*, range much farther north and northwest of Missouri. Hall and Clements (9) cite thirteen species and varieties under *A. glauca*, or rather *A. Dracunculus*, which would indicate that *glauca* is a very polymorphous species.

2. *ARTEMISIA GLAUCÀ CERNUA* (Nutt.) n. var.

A. cernua Nutt., Gen 2: 142. 1818.

TYPE LOCALITY: Saint Louis, Missouri.

Cited for Missouri by Rydberg (15) who segregates it from *A. dracunculoides* by the more diffuse habit, and nodding tips of the flowering branches. The only reason I have for retaining this as a variety of *A. glauca*, is that it is farther away from *glauca* than is *A. dracunculoides*, and appears to have a slightly different range.

As long as it can be distinguished in the field and the herbarium it should be designated by name.

Britton [1], Britton & Brown (2) and Robinson and Fernald (13) do not recognize this variety for the Manual Range, although the type was collected near Saint Louis, Missouri.

SPECIMENS EXAMINED:

MISSOURI: Dodson, *Mackenzie*, September 26, 1897, as *A. dracunculoides*, I. S. C. Herb.; Dodson, *Mackenzie*, September 26, 1897, as *A. dracunculoides*, U.S.N.M. Herb, 318357; Lees Summit, *Mackenzie*, 408, September 9, 1901, as *A. dracunculoides*, D. Herb.; Dodson, *Mackenzie*, September 26, 1897, as *A. dracunculoides*, M. Herb.; Lees Summit, *Mackenzie* 408, September 9, 1901, M. Herb.; Clark County, *Mead*, date not given, Gray Herb.

ILLINOIS: Lee County, *Brendel*, date not given, as *A. dra-*

cunculoides, U. of Ill. Herb.; Fountaindale, Bebb, date not given, Gray Herb.

NEBRASKA: Omaha, Eastman, October 1, 1915, as *A. dracunculoides*, U. of Ill. Herb.

NORTH DAKOTA: Pleasant Lake, Lunell 316, July 28, 1912, and September 2, 1912, both on one sheet, as *A. dracunculoides*, U. of Ill. Herb.; Dunsiette, Lunell, July 2, 1912, as *A. dracunculoides*, D. Herb.

CANADA: Lethbridge, Alberta, Macoun 10959, August 7, 1895, as *A. dracunculoides*, U. S. N. M. Herb. 389197.

NEW MEXICO: Organ Mountains, Wooten, September 17, 1893, as *A. dracunculoides*, U. of Ill. Herb.

IOWA: Plymouth County, Brown, October 1, 1902, as *A. dracunculoides*, I. S. C. Herb; Clear Lake, Cratty, August 9, 1918, as *A. dracunculoides*, I. S. C. Herb.; Fayette, Post, October 31, 1896, as *A. dracunculoides*, I.S.C. Herb.; Charles City, Tuttle, September 10, 1918, as *A. dracunculoides*, I.S.C. Herb.; Rock Rapids, Pammel, September 14, 1922, as *A. dracunculoides*, I.S.C. Herb.; Clear Lake, Pammel, October 25, 1919, as *A. dracunculoides*, I.S.C. Herb.; Mason City, Pammel and McNider 1084, date not given, as *A. dracunculoides*, I.S.C. Herb.; Spirit Lake, Pammel, August 28, 1918, as *A. dracunculoides*, I.S.C. Herb.; Sioux City, Pammel, August 30, 1895, as *A. canadensis*, I.S.C. Herb.; Charles City, Pammel, September, 1919, as *A. dracunculoides*, I.S.C. Herb.; Rock Rapids, Pammel, August 28, 1918, as *A. dracunculoides*, I.S.C. Herb.; Winnesheik, Fitzpatrick, August 14, 1899, as *A. dracunculoides*, I.S.C. Herb.; Des Moines, Pammel 1277, July 14, 1897, as *A. dracunculoides*, Gray Herb.; Muscatine, Mackenzie 549, September 1, 1893, M. Herb.

SOUTH DAKOTA: Opposite Hawarden, Iowa, Pammel, Aug. 29, 1895, as *A. dracunculoides*, I.S.C. Herb.

3. ARTEMISIA CAUDATA Michx. Fl. Bor. Am 2: VBT. 1803.
A. variabilis americana Besser, Bull. Soc. Nat. Mosc. 8: 24. 1835.

A. Lewisii T. & G. Fl. N. Am 2: 417. 1843, excluding synonymy, which seems to have been founded on several different species, one of which was *A. caudata*.

A. campestris caudata (Michx.) Hall and Clements, The N. Am. Species of *Artemisia*, 122. 1923.

TYPE LOCALITY: Banks of the Missouri River, near Saint Louis, Mo.

Hall and Clements (9) place this species as a variety under *A. campestris*, which is a low, stiff, perennial (or even shrubby?) species of the Mediterranean Region, but it seems to me best to keep it distinct on account of its biennial character and tall stature, often over 15 decimeters high, rarely under 6 decimeters, while *A. campestris* is only 1 to 6 decimeters high, according to Clements and Hall.

Cited for Missouri by Torrey and Gray (18), Rydberg (15), Hall and Clements (9), Egzert (7), Tracy (19) and Shepard (16).

SPECIMENS EXAMINED:

MISSOURI: Monteer, *Bush* 3599, August 8, 1905, U.S.N.M. Herb. 492078; Monteer, *Palmer* 19294, October 5, 1920, P. Herb.; Monteer, *Bush* 3595, October 8, 1905, M. Herb.; Monteer, *Bush* 201, July 27, 1899 M. Herb.

MICHIGAN: Burt Lake, *Ehlers* 1250, August 22, 1920, U. of Ill. Herb.; Big Stone Bay, *Gates* 9890, August 19, 1916, U. of Ill. Herb.

ILLINOIS: Peoria, *McDonald*, August, 1887, U. of Ill. Herb.; Peoria, *Brendel*, date not given, U. of Ill. Herb.; Peoria, *McDonald*, August, 1901 U. of Ill. Herb.; Peoria, *McDonald*, September, 1901, U. of Ill. Herb.; Savanna, *Waite*, May, 1887, U. of Ill. Herb.; Algonquin, *Nason*, date not given, U. of Ill. Herb.; no locality given, *Brendel*, date not given, U. of Ill. Herb.

KANSAS: Meade County, *Carleton* 528, September, 1891, U. of Ill. Herb.; Leeds, *Lunell*, September 14, 1901, U. of Ill. Herb.; Butte, *Lunell*, August 5, 1906, M. Herb.

MAINE: Old Orchard, *Knight*, August 24, 1905 U. of Ill. Herb.; Old Orchard, *Knight*, August 24, 1905, M. Herb.

NEW YORK: Rochester, *Baxter*, September, 1910, as *A. canadensis*, U. of Ill. Herb.

MASSACHUSETTS: Lynn Beach, *Summers*, August 17, 1887 U. S. N. M. Herb. 295315; Reserve, *Forbes*, August 16, 1902,

U. of Ill Herb.; Revere, *Forbes*, October 5, 1902, U. of Ill Herb.; Revere, *Forbes*, September 20, 1902, U. of Ill. Herb.

MINNESOTA: Saint Paul, *Seymour*, August 21, 1884, U. of Ill. Herb.; Crookston, *Westley*, September, 1918, U. of Ill Herb.

INDIANA: Pine, *Chase* 579, September 1, 1897, U. of Ill. Herb.; Indiana Harbor, *Deam* 5272, August 30, 1908, M. Herb.

OKLAHOMA: Shattuck, *Stevens* 2916½, October 11, 1913, U. of Ill Herb.; Arkansas, *Bush* 533, September 24, 1895, M. Herb.

WISCONSIN: Alma, *Palmer* 28516, September 9, 1925, as *A. canadensis*, P. Herb.; Alma, *Palmer* 28516, September 9, 1925, as *A. dracunculoides*, P. Herb.; Madison, *Cheney*, September 1, 1893, U. of Ill. Herb.; Reine, *Davis*, September 21, 1878, U. of Ill Herb.

IOWA: Waterville, *Pammel*, August 23, 1920, I.S.C.Herb.; Granite, *Pammel*, August 28, 1920, I.S.C., Herb.; Harlantown, *Pammel*, September 20, 1923, I.S.C. Herb.; Charles City, *Pammel*, and *Sherman* 3860, September 20, 1902, I.S.C. Herb.; Charles City, *Pammel* and *Sherman* 3860, September 20, 1902, I.S.C. Herb.; Clear Lake, *Pammel* and *Naylor* 520, September 1, 1925, I.S.C. Herb.; Clear Lake, *Pammel*, September 12, 1894, I.S.C. Herb.; Cherokee, *Pammel*, September 5, 1920, I.S.C. Herb.; Rock Rapids, *Pammel*, August 28, 1918, I.S.C. Herb.; Chickasaw, *Spiker*, month not given, 1925, I.S.C. Herb.; Mason City, *Pammel*, September 20, 1923, I.S.C. Herb.; Clarion, *Hayden*, July, 1925, I.S.C. Herb.; Delaware County, *Pammel*, August 23, 1920, I.S.C. Herb.; no locality given, Northeast Iowa, *Goddard*, August 12, 1895, I.S.C. Herb.; South High Lake, *Wolden*, August 11, 1922, I.S.C. Herb.; McGregor, *Pammel* 689, August 21, 1925, I.S.C. Herb.; Fayette, *Fink*, August 27, 1894, I.S.C. Herb.; McGregor, *Hayden*, September, 1919 I.S.C. Herb.; Decorah County, collector not given, August 7, 1881, I.S.C. Herb.; Jackson County, *Fitzpatrick*, August 19, 1900, U. of Ill. Herb.; Muscatine, *Mackenzie* 533, September 24, 1895, M. Herb.

NEW JERSEY: South Amboy, *Mackenzie* 1144, October 16, 1908, M. Herb.

VERMONT: Smuggler's Notch, *Eggleson*, July 10, 1894,
M. Herb.

COLORADO: Breckenridge, *Mackenzie* 294, August, 1901.
M. Herb.

4. (*ARTEMISIA BOREALIS CANADENSIS* (Michx.) n. var.

A. canadensis Michx. Fl. Bor. Am. 2: 129, 1803.

A. peucedanifolia Juss.; Besser, Bull. Soc. Nat. Mosc. 8: 91, 1835.

TYPE LOCALITY: Hudson Bay.

Cited for Missouri by Torrey and Gray (18), Peck (12), and Tracy (19), but these evidently refer to *A. caudata*, which is commonly mistaken for *A. canadensis*. As I now understand *A. canadensis*, it is a low, strongly cespitose perennial of the northern regions, and does not get so far South as Missouri.

5. *ARTEMISIA FRIGIDA* Willd. Sp. Pl. 3: 1838, 1804.

A. sericea Nutt Gen. 2: 143, 1818. Not *A. sericea* Weber, 1778.

TYPE LOCALITY: Eastern Siberia.

Cited for Missouri by Torrey and Gray (18) and Tracy (19), but up to 1900 no specimens of this species were known to me from the State, and all that I have any knowledge of are chance introductions along railroads and in waste places.

SPECIMENS EXAMINED:

MISSOURI: Sheffield, *Bush* 8409, September 17, 1916, U. S. N. M. Heb. 1088940, as *A. Carruthii*.

CANADA: Point Edward, Ontario. *Dodge* 265, August 11, 1911, M. Herb.; Point Edward, Ontario, *Dodge* 266, July 11, 1911, M. Herb.; Point Edward, Ontario, *Dodge* 267, July 5, 1910 M. Herb.

COLORADO: Pitkin County, *Mann*, July 20 to July 30, 1900, M. Herb; Breckenridge, *Mackenzie* 114, August, 1901, M. Herb.

MONTANA: Butte, *Lunell*, August 26, 1906. M. Herb.; Polson, *Umbach*, August 19, 1907, M. Herb.

WYOMING: Madison Canon, *Nelson* 6867, August 30, 1899, M. Herb.; Daramie, *Nelson* 6867, September 16, 1899, M. Herb.; Laramie, *Nelson* 8163, September 5, 1900, M. Herb.

MINNESOTA: Minneapolis, *Aiton*, September 11, year not given, M. Herb.

6. ARTEMISIA BIENNIS Willd. Phytogr. 11. 1794.

TYPE LOCALITY: "New Zealand."

Cited for Missouri by Torrey and Gray (18), Eggert (7), Bush (3), Tracy (19), Mackenzie and Bush (10), Britton and Brown (2), Hall and Clements (9), Robinson and Fernald (13), Gray (8), and Small (17).

SPECIMENS EXAMINED:

MISSOURI: Courtney, *Bush*, 7784, September 13, 1916, U.S.N.M. Herb.; Sheffield, *Bush* 3300, August 30, 1905, U.S.N.M. Herb.; Thornton, *Mackenzie* 375, October 2, 1898, M. Herb.; Sheffield, *Mackenzie*, October 31, 1897, M. Herb.

ILLINOIS: No locality given, *Welsch*, date not given, as *A. caudata*, U. of Ill. Herb.

INDIANA: Montpelier, *Deam* 640, September 2, 1905, M. Herb.

IOWA: Osage, *Tuttle*, month not given, 1916, I.S.C. Herb.; McCallsburg, *Pickford* and *Guthrie*, September 24, 1924, I.S.C. Herb.; Des Moines, *Carver*, September, 1925, I.S.S. Herb.; Decatur County, *Anderson*, September 29, 1900, I.S.C. Herb.; Boone, *Pammel*, month not given, 1902, I.S.C. Herb.; Chickasaw County, *Spiker*, month not given, 1925, I.S.C. Herb.; Woodbury County, *Burns*, month not given, 1902, I.S.C. Herb.; Granite, *Pammel*, August 28, 1920, I.S.C. Herb.; Muscatine, *Mackenzie* 346, October 20, 1892, M. Herb.

COLORADO: Breckenridge, *Mackenzie* 236, 1901, M. Herb.

NORTH DAKOTA: Leeds, *Lunell*, September 14, 1901, M. Herb.

WYOMING: Laramie, *Nelson* 8164, August 30, 1900, M. Herb.

MAINE: Bangor, *Knight*, September 24, 1905, M. Herb.

7. *ARTEMISIA ANNUA* L. Sp. Pl. 847. 1753.

TYPE LOCALITY: Siberia.

Cited for Missouri by Daniels (6), Mackenzie and Bush (10), Palmer (11), Bush (4), Tracy (19), and Hall and Clements (9).

SPECIMENS EXAMINED:

MICHIGAN: Detroit, Billington 132, September 19, 1916, M. Herb.

IOWA: Decatur County, *Fitzpatrick*, September 28, 1898, I.S.C. Herb.; Mount Pleasant, *Jacques*, month not given, 1918, I.S.C. Herb.; Decatur County, *Anderson*, September 17, 1904, I.S.C. Herb.; Ottumwa, *Pammel*, October 5, 1923, I.S.C., Herb.; Newton, *Pammel* 540, September 8, 1925, I.S.C. Herb.; Keosauqua, *Pammel* and *Reis* 457, September 10, 1925, I.S.C. Herb.; Keosauqua, *Secor*, October, 1925, I.S.C. Herb.; Logan, *Heterich*, October 3, 1923, I.S.C. Herb.; Mount Pleasant, *Pammel*, October 3, 1923, I.S.C. Herb.; Muscatine, *Mackenzie* 347, October 1, 1893, M. Herb.; Muscatine, *Mackenzie* 347, October 1, 1893, M. Herb.

8. (*ARTEMISIA VULGARIS* L. Sp. Pl. 848. 1753.)

TYPE LOCALITY: Europe.

Cited for Missouri by Tracy (19), who says it is common westward, but I can not imagine what Tracy had in mind when he wrote that, as *A. vulgaris* is not common anywhere in Missouri, and is only found occasionally where trash from gardens has been dumped. Bush (4) reported this for Jackson County, Missouri, but the specimens prove to be *A. ludoviciana*.

9. (*ARTEMISIA MEXICANA* Willd.; Spreng, Syst. 3: 490, 1826.)

A. vulgaris mexicana (Willd.) T. & G. Fl. N. Am. 2: 421. 1843.

TYPE LOCALITY: Mexico.

Cited for Missouri by Britton & Brown (2), Hall and Clements (9), citing Bush 412, Palmer (11), and Mackenzie

and Bush (10), but it is very evident that all these refer to *A. ludoviciana Lindheimeriana*.

10. ARTEMISIA LUDOVICIANA Nutt. Gen. 2: 143. 1818.

A. vulgaris ludoviciana (Nutt.) Hall and Clements, The N. Am. species of *Artemisia*, 76, 1923.

TYPE LOCALITY: Banks of the Mississippi, near Saint Louis, Missouri.

Cited for Missouri by Torrey and Gray (18), Tracy (19), Britton (1), Britton & Brown (2), Rydberg (14), Bush (4), as *A. vulgaris*, Palmer (41), Mackenzie and Bush (10), and Rydberg (15).

SPECIMENS EXAMINED:

MISSOURI: Greenwood, *Bush* 2906, October 28, 1915, U. of Ill. Herb.; Dodson, *Bush* 7844, September 27, 1915, U.S.N. M. Herb.; 1088909; Springfield, *Standley* 8637, October 10, 1911, U.S.N.M. Herb. 687578; Courtney, *Bush* 6509, October 10, 1911, U.S.N.M. Herb. 673598, as *A. vulgaris*; Prosperity Junction, *Eggleston*, 12086, September 30, and October 1, 1915, U.S.N.M. Herb. 644178; Lees Summit, *Mackenzie* 424, September 9, 1901, D. Herb.; Joplin, *Palmer* 18752, August 17; 1920, P. Herb.; Webb City, *Palmer*, 17106, October 3, 1919, P. Herb.; Oronogo, *Palmer* 23916, Sept. 28, 1923, P. Herb.; Lees Summit, *Mackenzie* 424, September 4, 1901, M. Herb.; Dodson, *Mackenzie*, September 19, 1897, M. Herb.; Dodson, *Mackenzie* 596, October 8, 1901, M. Herb.

ILLINOIS: Chicago, *Chase*, September 22, 1896, U. of Ill. Herb.

OKLAHOMA: Cherokee Outlet, *Carleton*, September 2, 1891, U. of Ill. Herb.; Sapulpa, *Bush* 1320, September 28, 1895, M. Herb.

INDIANA: Plymouth, *Deam* 34761, September 14, 1921, D. Herb.

TEXAS: Tarrant County, *Ruth* 320, U. of Ill. Herb.

WYOMING: Mammoth Hot Springs, *Dewart*, June, 1889, U. of Ill. Herb.

IOWA: Wall Lake, *Pammel*, September 21, 1923, I. S. C. Herb.

KANSAS: Wichita, *Carleton*, September 15, 1888, U. of Ill. Herb.; Wichita, *Carleton* 142, September 15, 1888, U. of Ill. Herb.; Wyandotte, *Mackenzie*, October 20, 1896, M. Herb.

11. *ARTEMISIA LUDOVICIANA LINDHEIMERIANA* (Scheele)
n. comb.

A. vulgaris americana Besser, *Linnaea* 15: 105, in part, 1841.

A. cuneifolia Scheele, *Linnaea* 22: 162. 1849, not *A. cuneifolia*, DC. 1837.

A. Lindheimeriana Scheele, *Linnaea* 22: 163. 1849.

A. mexicana Britton & Brown, *Ill Flora* 3: 539. 1913.
Not *A. mexicana* Willd. 1826.

TYPE LOCALITY: Cibolo River, New Braunfels, Texas.

Cited for Missouri by Britton & Brown (2), as *A. mexicana*, Mackenzie and Bush (10), as *A. mexicana*, Hall and Clements (9), as *A. mexicana*, Palmer (11), as *A. mexicana*, and Rydberg (15).

SPECIMENS EXAMINED:

MISSOURI: Raytown, *Mackenzie*, September 19, 1897, M. Herb.; Lees Summit, *Mackenzie*, July 6, 1900, M. Herb.; Lees Summit, *Mackenzie*, July 6, 1900, M. Herb.; Dodson, *Mackenzie*, September 26, 1897, M. Herb.; Rayton, *Mackenzie*, September 19, 1897, I.S.C. Herb.; Dodson, *Mackenzie*, September 26, 1897, I.S.C. Herb.; Dodson, *Bush* 7844, September 27, 1915, U. of Ill. Herb.; Greenwood, *Bush* 4121, September 19, 1906, U.S.N.M. Herb.; Kansas City, *Bush* 11051, 11051-A, 11052 and 11052-A, September 21, 1926; Greenwood, *Bush* 4121, September 19, 1906, M. Herb.; Greenwood, *Bush* 4121, September 19, 1906, M. Herb.; Webb City, *Palmer* 16244, August 31, 1919, P. Herb.

12. *Artemisia gnaphalodes* Nutt. Gen. 2: 143. 1818.

A. ludoviciana gnaphalodes (Nutt.) T. & G. Fl. N. Am. 2: 420. 1843.

A. vulgaris gnaphalodes (Nutt.) O. Kuntze, Rev. Gen. Pl. 309. 1891.

A. rhizomata A. Nelson, Bull. Torr. Club 27: 34, in part, 1900.

TYPE LOCALITY: Green Bay, Wisconsin.

Cited from Missouri by Torrey and Gray (18), Mackenzie and Bush (10), Britton & Brown (2), Rydberg (15), Hall and Clements (9), and Bush (5).

SPECIMENS EXAMINED:

MISSOURI: Sibley, *Mackenzie*, 564, October 2, 1901, D. Herb.; Courtney, *Bush* 5858, July 2, 1909, U.S.N.M. Herb. 648069, Lees Summit, *Mackenzie*, July 6, 1900, M. Herb.; Harlem, *Mackenzie*, July 23, 1899, M. Herb.; Harlem, *Mackenzie*, July 23, 1899, M. Herb.; Harlem, *Mackenzie*, July 12, 1897, M. Herb.; Sibley, *Mackenzie* 564, October 2, 1901, M. Herb.

INDIANA: Rochester, Deam 39243, August 2, 1923, D. Herb.

WYOMING: Laramie, Pammel 1952, August 7, 1901, D. Herb.

IDAHO: Sand Point, *Umbach*, August 24, 1901, M. Herb.

NORTH DAKOTA: Leeds, *Lunell*, September 14, 1901, D. Herb.; Bismarck, *Seymour*, August 28, 1884, U. of Ill. Herb.; Fargo, *Seymour*, August 28, 1884, U. of Ill. Herb.; Leeds, *Lunell*, September 25, 1905, M. Herb.; Leeds, *Lunell*, September 3, 1906, M. Herb.

KANSAS: Kansas City, *Mackenzie*, October 20, 1896, I. S.C. Herb.; Wichita, *Andrews*, date not given, I.S.C. Herb.; Rockport, *Bartholomew*, September 6, 1891, U. of Ill. Herb.

MONTANA: Butte, *Lunell*, August 26, 1906, M. Herb.

ILLINOIS: St. Clair County, collector and date not given, Brendel Herbarium, U. of Ill. Herb.; Chicago, *Lansing*, September 9, 1906, U. of Ill. Herb.; Savanna, *Clinton*, August 28, 1894, U. of Ill. Herb.; Fountaintdale, *Bebb*, month not given, 1871, U. of Ill. Herb.

OKLAHOMA: Kenton, *Stevens* 450, May 13, 1913, U. of Ill. Herb.; Alva, *Stevens* 2869, October 1, 1913, U. of Ill. Herb.; Hollis, *Stevens* 1118, June 21, 1913, U. of Ill. Herb.; Oklahoma City, *Stevens* 164, U. of Ill. Herb.

UTAH: Salt Lake City, *Mann*, September, 1900, M. Herb.

MINNESOTA: Sandy Lake, *Sandberg* 796, August 12, 1891, U. of Ill. Herb.; Glenwood, *Cowles* 3, June 21, 1907, U. of Ill. Herb.; Minneapolis, *Aiton*, September, year not given. U. of Ill. Herb.; no locality given, *Ward*, month not given, 1863, U. of Ill. Herb.

COLORADO: Colorado Springs, *Mulford*, August 31, 1892, U. of Ill. Herb.; Estes Park, *Clokey* 3956, September 14, 1920, U. of Ill. Herb.; Lake Eldon, *Clokey*, 3771, August 18, 1918, U. of Ill. Herb.; Grand Lake, *Campbell*, July, 1896, M. Herb.; Lake Eldora, *Clokey* 3171, August 8, 1918, M. Herb.; Breckenridge, *Mackenzie* 247, August, 1901, M. Herb.

WISCONSIN: Baraboo, *True*, August 24, 1892, U. of Ill. Herb.

SASKATCHEWAN: Estevan, *Cowles* 13, June 22, 1907, U. of Ill. Herb.

MICHIGAN: Point Edward, *Dodge* 268, July 11, 1922, M. Herb.; Point Edward, *Dodge* 269, July 11, 1911, M. Herb.; Wayne County, *Chandler*, August 17, 1916, M. Herb.

IOWA: Merrill, *Holtzen*, September, 1923, I.S.C. Herb.; Strawberry Point, *Pammel*, August 9, 1923, I.S.C. Herb.; Ames, *Pammel* and *Lynch*, September 15, 1920, I.S.C. Herb.; Missouri Valley, *Pammel*, June 11, 1920, I.S.C. Herb.; Delaware County, *Pammel*, August 23, 1920, I.S.C. Herb.; Sioux City, *Pammel*, July 25, 1922, I.S.C. Herb.; Cedar Falls, *Pammel*, September 28, 1920, I.S.C. Herb.; Battle Creek, *Pammel*, July 23, 1922, I.S.C. Herb.; Chariton, *Pammel*, September 15, 1922, I.S.C. Herb.; Granite, *Pammel*, August 28, 1920, I.S.C. Herb.; High Lake, *Wolden* 712, September 14, 1922, I.S.C. Herb.; Montrose, *Luechel* 202, July 31, 1924, I.S.C. Herb.; Armstrong, *Cratty*, September 5, 1897, I.S.C. Herb.; Plymouth County, *Brown*, October 1, 1902, I.S.C. Herb.; Rock Rapids, *Pammel*, August 28, 1918, I.S.C. Herb.; Emmetsburg, *Pammel*, September 14, 1919, I.S.C. Herb.; Clear Lake, *Pammel*, September 12, 1924, I.S.C. Herb.; Hamilton, *Pammel*, October 28, 1923, I.S.C. Herb.; Pilot Mound, *Pammel*, October, 1918, I.S.C. Herb.; Decorah County, *Holway*, August 24, 1879, I.S.C. Herb.; Lake Mills, *Pammel*, August 21, 1918, I.S.C. Herb.; Spirit Lake, *Pammel*, August 28, 1918, I.S.C. Herb.; Armstrong, *Pammel*, July, 1902, I.S.C. Herb.; Greene,

Pammel, September 1, 1919, I.S.C. Herb.; Lake Mills, *Pammel*, August 21, 1918, I.S.S. Herb.; Ames, *Pammel*, September, 1912, I.S.C. Herb.; New Hampton, *Pammel*, 483, August 21, 1925, I.S.C. Herb.; Osceola, *Pammel*, September 27, 1924, I.S.C. Herb.; Sioux City, *Pammel*, August 30, 1895, I.S.C. Herb.; Ontario, *Hodson*, August 24 1897, I.S.C. Herb.; Charles City, *Pammel* and *Sherman* 3867, September 20, 1902, I.S.C. Herb.; Hawarden, *Pammel*, August, 1895, I.S.C. Herb.; Kelley, *Clayton* 170, July, August, 1911, I.S.C. Herb.; Kelley, *Clayton*, 28, July, August, 1911, I.S.C. Herb.; Fayette, *Fink*, August 4, 1894, I.S.C. Herb.; Fyaeette, *Fink*, August 4, 1894, I.S.C. Herb.; Fayette, *Fink*, September 1892, I.S.C. Herb.; Northwest Valley, *Pammel*, August 14, 1894, I.S.C. Herb.; Cherokee, *Pammel*, September 5, 1920, I.S.C. Herb.; Cherokee, *Pammel*, September 5, 1920, I.S.C. Herb.; Dell Rapids, *Pammel*, July 29, 1922, I.S.C. Herb.; No locality given, *Goddard*, August 24, 1895, I.S.C. Herb.; Charles City, *Pammel*, September 3, 1916, I.S.C. Herb.; Frazer, collector not given, September 11, 1911, I.S.C. Herb.; Osage, *Tuttle*, August, 1913, I.S.C. Herb.; *Tuttle*, August, 1913, I.S.C. Herb.; Decatur County, *Anderson*, September 9, 1913, I.S.C. Herb.; Ames, collector not given, month not given, 1911, I.S.C. Herb.; Little Rock, *Pammel*, August 29, 1918, I.S.C. Herb.; Algona, *Watson*, September 5, 1902, I.S.C. Herb.; Ames, *Pammel*, month not given, 1907, I.S.C. Herb.; College Park, *Rolfs*, month not given, 1896, I.S.C. Herb.; Pocahontas, *Mecham*, 1917, I.S.C. Herb.; Clear Lake, *Pammel* and *Naylor* 521, September 1 1925, I.S.C. Herb.; Armstrong, *Cratty*, September, 1883, I.S.C. Herb.; Mason City, *Pammel* and *McNider* 1085, September 22, 1925, I.S.C. Herb.; Gillett Grove, *Pammel*, August 28, 1912, I.S.C. Herb.; Mason City, *Pammel*, August 21, 1894, I.S.C. Herb.; Hazelton, *Pammel* 708, August 24, 1925, I.S.C. Herb.; Muscatine, *Mackenzie*, August 17, 1893, M. Herb.

13. ARTEMISIA CARRUTHII Wood; Carruth, Trans. Kans. Acad. Sci. 5: 51. 1877.

A. *Kansana* Britton; Britton & Brown, Ill. Flora 3: 466. 1898.

A. *coloradensis* Osterhout, Bull. Torr. Club 27: 506. 1900.

TYPE LOCALITY: Lawrence, Kansas.

Cited for Missouri by Britton & Brown (2), Mackenzie & Bush (10), Hall and Clements (9), and Rydberg (15).

SPECIMENS EXAMINED:

MISSOURI: Sheffield, *Bush* 3333, September 14, 1905, U. S.N.M. Herb.; 607712; Sheffield, *Bush* 3333, September 14, 1905, M. Herb.; Sheffield, *Mackenzie*, July 29, 1901, M. Herb.

KANSAS: Kearney County, *Hitchcock*, August 24, 1897, M. Herb.; Winona, *Hitchcock*, May, 1895, M. Herb.

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